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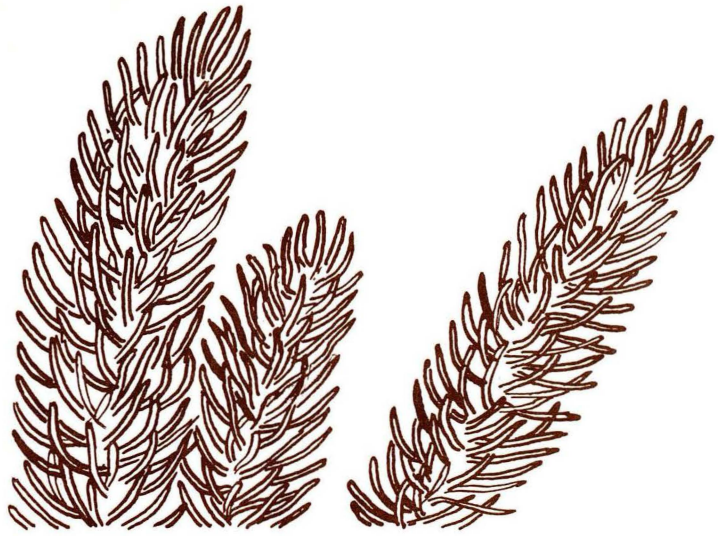
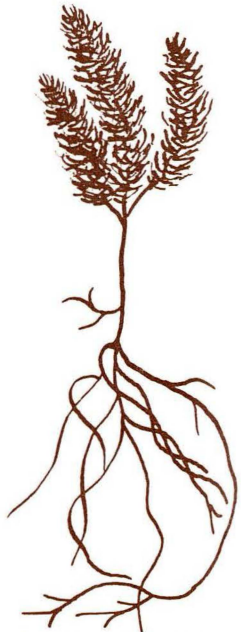


CONTROL OF LOPHODERMIUM NEEDLECAST DISEASE IN NURSERIES AND CHRISTMAS TREE PLANTATIONS

Thomas H. Nicholls
and
Darroll D. Skilling



NORTH CENTRAL FOREST EXPERIMENT STATION
FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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CONTROL OF *LOPHODERMIUM* NEEDLECAST DISEASE IN NURSERIES AND CHRISTMAS TREE PLANTATIONS

Thomas H. Nicholls and Darroll D. Skilling

INTRODUCTION

These recommendations are based upon studies initiated by the USDA Forest Service as a result of an outbreak of *Lophodermium* needlecast in several nurseries in the Lake States that spread to plantations throughout the United States due, in part, to shipments of diseased seedlings during the late 1960's and early 1970's. Results have been published at various stages of these studies (see References, page 11).

Nurseries adopting control recommendations developed and refined during the course of these studies were again producing healthy stock by 1969-1971 (figs. 1, 2, and 3). This publication is intended to provide a summation of these recommendations to be used by nursery and plantation managers for designing operational control programs patterned to their particular needs.

EXTENT OF DAMAGE

During 1966 and 1967, millions of red pine (*Pinus resinosa* Ait.) and Scotch pine (*P. sylvestris* L.) seedlings in several nurseries in Minnesota, Wisconsin, and Michigan were killed or severely damaged by the needlecast fungus, *Lophodermium pinastri* Schrad. ex Fr. Chev. (figs. 4 and 5).

Lophodermium has been reported in at least 30 tree nurseries in Maine, Michigan, Wisconsin, Minnesota, Washington, West Virginia, Pennsylvania, North Carolina, South Carolina, Ontario, and Nova Scotia (fig. 6). The disease has probably infected nurseries in many other States. Many commercial tree nurseries ship stock throughout the entire United States. As a result, *Lophodermium* has appeared in plantations wherever climatic conditions are conducive to disease development.

In 1970, serious damage from *L. pinastri* began to appear in Scotch pine Christmas tree plantations in the Lake States Region (fig. 7). By 1971 *Lophodermium* needlecast was causing catastrophic damage in plantations from the New England States to the West Coast (Skilling and Nicholls 1971).

The disease has damaged plantations in such diverse locations as British Columbia, Connecticut, Indiana, Michigan, Wisconsin, Massachusetts, Washington, North Carolina, South Carolina, Ohio, Pennsylvania, Vermont, New York, Kentucky, Oregon, Minnesota, and West Virginia (fig. 6). Several million trees were made unsalable by this disease. Therefore, Scotch pine plantations throughout the United States and Canada should be closely watched for *Lophodermium* infection. If detected, control measures for use in

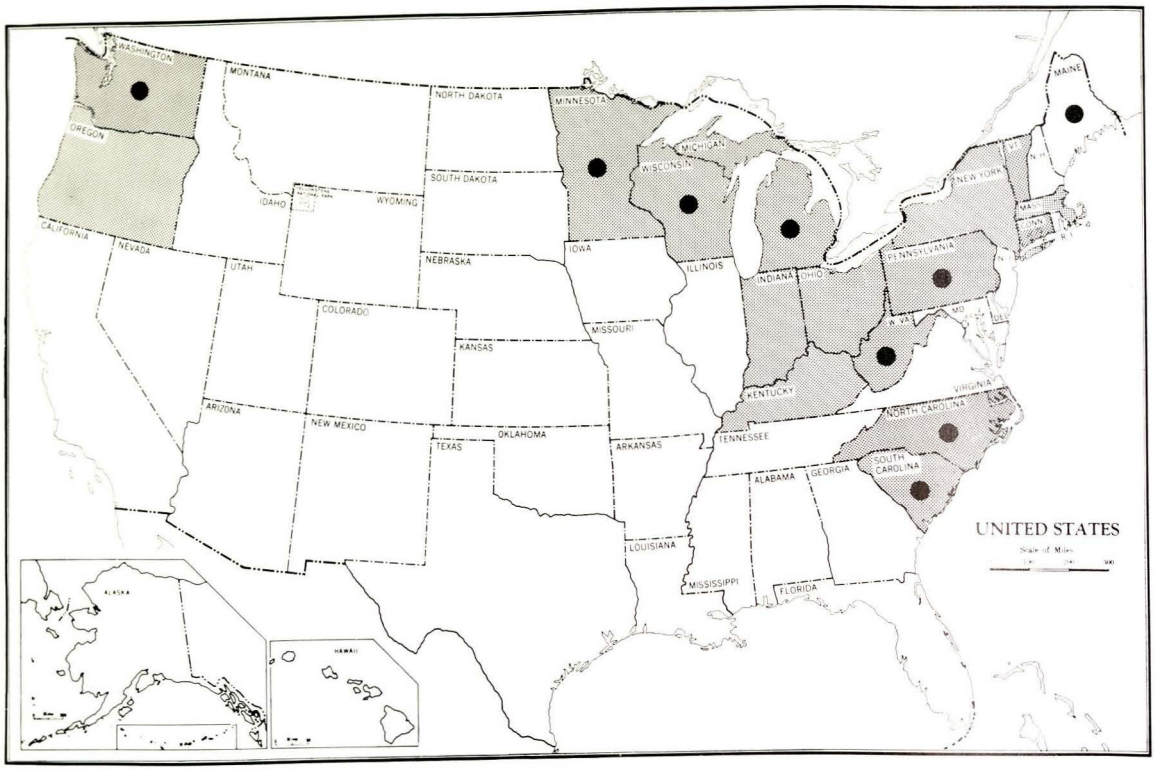

Figure 6.--*Shaded States denote destribution of* L. pinastri *in Scotch pine Christmas tree plantations. States with black dots have had outbreaks of* Lophodermium *in nurseries growing red pine, Scotch pine, or both.*

plantations should be started as soon as possible (fig. 8).

Before these attacks, *L. pinastri* had not been considered an important pathogen of either red or Scotch pine in the United States even though it long has been considered a serious problem in Scotch pine nurseries and plantations in Europe. There had been only one report attributing damage by it in this country: to red pine in a Massachusetts nursery; this report was published by Spaulding in 1935. The increased use of Scotch pine in the United States in both nurseries and plantations for Christmas trees may have contributed to the rather sudden buildup of the pathogenic strain in this country.

Millar and Watson (1971) recently reported on two *L. pinastri* strains found on Scotch pine in Scotland. Both might be present in Europe and the United States. One strain seems to be entirely saprophytic, attacking only older needles that are in poor vigor. The other strain, however, is pathogenic and can attack healthy needles of all ages. It is this strain that is currently causing the problem.

SUSCEPTIBLE HOSTS

Red and Scotch pines are most susceptible to *L. pinastri*. The short-needled Scotch pine varieties are highly susceptible to damage by the fungus. Long-needled Scotch pine varieties are more resistant, but this could change if certain genetic changes occur in either the host or fungus that might increase the susceptibility of a variety.

SYMPTOMS AND LIFE HISTORY

Brown spots, often with yellow margins, are produced on needles in the spring as a result of the previous year's infection (fig. 9). These infected needles begin yellowing and turning brown in late April, May, and June. The damage is more severe on the lower parts of trees, but it is not unusual for all the foliage to be infected (fig. 10). The disease can be distinguished from winter burn because only the foliage above the snowline turns brown on winter-burned trees (fig. 11). On some trees both winter burn and *Lophodermium* may be found.

Lophodermium fruiting bodies develop on the brown needles that fall off trees in June and July, many of which lodge in the trees. They also develop on dead needles still attached to tree branches. These fruiting bodies mature by late August and look like tiny, black, football-shaped structures having a longitudinal slit down the center. During rainy weather in August, September, and October, these fruiting bodies absorb moisture, their slits open, and their fungus spores are forcibly discharged into the air (fig. 12). When these windborne spores land on red or Scotch pine needles, the spores germinate and infect the needles if environmental conditions are favorable. Control measures must be taken before this time if foliage is to be protected.

By late fall, most of the dead needles are cast, which leaves only the current-year needles on the trees (fig. 13). Trees in this condition are unsalable as Christmas trees. In nurseries, there is often high mortality in young seedlings (fig. 5). In nurseries as well as plantations, most older trees survive by the development of new needles the following spring. These new needles become infected in late summer and fall and the disease cycle is repeated.

EARLY DETECTION VITAL

Nurseries and plantations should be closely watched for outbreaks of *Lophodermium*, particularly in the spring when symptoms are most evident (fig. 14). Train workers to be alert for infected trees on

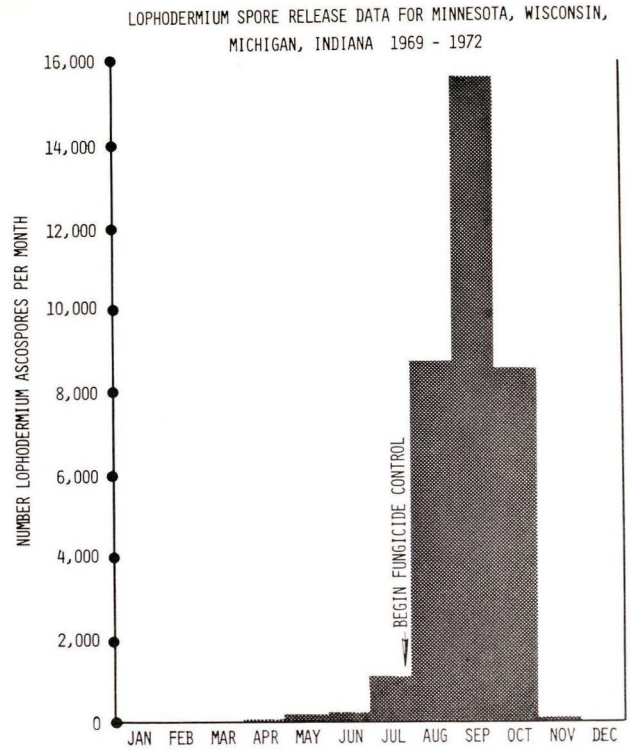

Figure 12.--*Combined* Lophodermium *spore release data obtained in nurseries and Christmas tree plantations in Minnesota, Wisconsin, Michigan, and Indiana, 1969-1972. For effective control, fungicides must be applied to foliage just before and during the major spore dispersal period which begins in August and continues into October. September is the key month for spore release and infection in all four States in both nurseries and plantations.*

which over 20 percent of their total foliage is brown in May or June. When such trees are detected, contact the local Extension Forester or Forest Pest Management office to arrange for positive identification by a plant pathologist. This service is usually available free from the following agencies: Plant Disease Clinics, Departments of Plant Pathology, State Universities; Plant Pest Divisions, State Departments of Natural Resources or Agriculture; or Forest Pest Management, State and Private Forestry, USDA Forest Service.

Early detection will prevent serious economic losses for growers because control

can be achieved faster in lightly infected nurseries and plantations. It is essential that the protective fungicide be applied before the fungus spores discharged by the fruiting bodies land on healthy needles during rainy periods in August, September, and October (fig. 12).

In plantations, it usually takes 2 to 3 yrs for *Lophodermium* to reach epidemic status because the disease might subside during dry years and then increase in severity as soon as normal moisture conditions return. In nurseries where irrigation is used and where seedlings are grown in densely packed, moist beds, the disease can reach epidemic conditions each year.

HOW TO APPLY FUNGICIDES

When Not To Spray

Fungicides should not be applied during rain because it will wash off before it has an opportunity to dry on the needles. Once dried, fungicides resist rainfall; chlorothalonil more so than maneb. Moreover, there is some evidence that rain redistributes chlorothalonil residues over the foliage after it has dried on needles. Do not spray when it is windy because this prevents even foliage coverage. Do not spray plantations that do not show signs of *Lophodermium* infection unless they are in danger of infection from adjacent infected plantations.

When To Spray

The exact timing of control procedures may vary somewhat with geographical location. The following recommended spray schedules apply generally to the Lake States and Northeastern States. For other areas, determine the major *Lophodermium* spore release and infection periods and apply one of the recommended fungicides before spore release and follow with other sprays at 2- to 3-week intervals during the major spore-release periods.

Nursery.--For maximum control, four sprays should be applied just before and during the period when *Lophodermium* fruiting bodies are mature and spores are released (fig. 12). Sprays should be applied about August 1, and 15, and September 1, and 15. In areas where infection is high, an October 1 spray may also be required if there is prolonged rainy weather.

Plantations.--Infected plantations should be sprayed three times: about July 25 (when new foliage is fully elongated), about August 15, and about September 10. An additional spray in late September or early October may be required if there is unusually wet weather during this period.

Nursery stock has high value per acre; therefore, it is economically feasible to invest in the more intensive spraying schedule recommended for nurseries, which would be impractical for plantations. The objective for using fungicides in nurseries is complete control to ensure that more plantations will not be infected by the introduction of diseased seedlings. The objective for using fungicides in plantations is to produce healthy trees having dense foliage that will be salable on Christmas tree lots, which the recommended spray schedule will do effectively.

What To Use

Two fungicides are currently registered for control of *Lophodermium* needlecast: chlorothalonil (tetrachloroisophthalonitrile) (Bravo W-75, Daconil 2787, Bravo 6F) and maneb (Manganese ethylene bisdithiocarbamate) (Manzate 200, Manzate D, Dithane M-22, Dithane M-45).[1] Both are easy to handle, noncorrosive to spray machinery, relatively safe, and have proved effective in controlling *Lophodermium* in tree nurseries and Christmas tree plantations. Both are compatible with wettable powder formulations of most commonly used fungicides, insecticides, and miticides. Follow label for emulsifiable formulations.

Benomyl (methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate) (Benlate) provides excellent *Lophodermium* control, but it has not, as yet, been registered for this use (Nicholls 1973).

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[1]*Mention of trade names does not constitute endorsement of the products by the USDA Forest Service.*

Figure 1.--*Maneb-protected 2-0 red pine in the foreground; unprotected beds in the background. Heavy mortality caused by* L. pinastri *occurred in the unprotected trees. (Picture taken in June 1969.)*

Figure 3.--*Infrared picture of 2-0 red pine. Beds that are bright red had been sprayed with maneb and are healthy as indicated by the red color. The bed that is not bright red was not sprayed and the trees were killed or heavily damaged by* L. pinastri *as indicated by the tannish-brown color of the foliage. (Picture taken in May 1969.)*

Figure 2.--*Maneb-treated 3-0 red pine are healthy. The bed to the left, with the brown trees, was not sprayed with maneb and the trees were heavily infected. Note that some infected trees are recovering by development of the terminal bud. (Picture taken in June 1969.)*

Figure 4.--*Three-yr-old red pine infected with* L. pinastri *in a Wisconsin nursery. Whole tree beds turned brown in several nurseries during the spring of 1966.*

Figure 5.--*Spanish Scotch pine seedlings in a Michigan nursery killed by* **L. pinastri** *during June 1968.*

Figure 8.--*The Scotch pine on the left was an unsprayed tree and the one on the right was sprayed three times in late summer and fall with a fungicide and was protected from infection.*

Figure 7.--*A Spanish Scotch pine Christmas tree plantation heavily infected with* Lophodermium *needlecast. (Picture taken in May 1973.)*

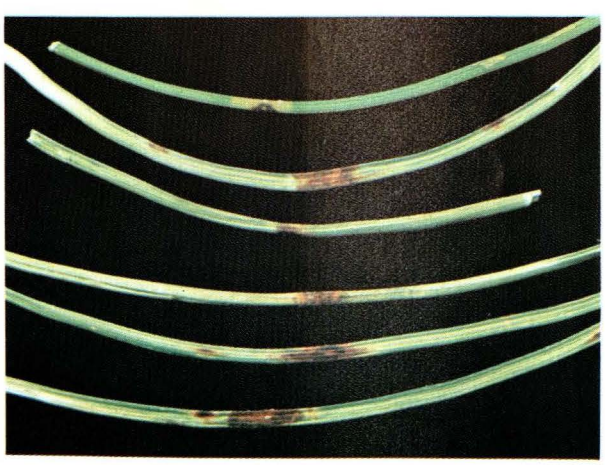

Figure 9.--*Needle spots on red pine caused by* **L. pinastri.** *The fungus eventually destroys the vascular system in needles after which entire needles turn brown.*

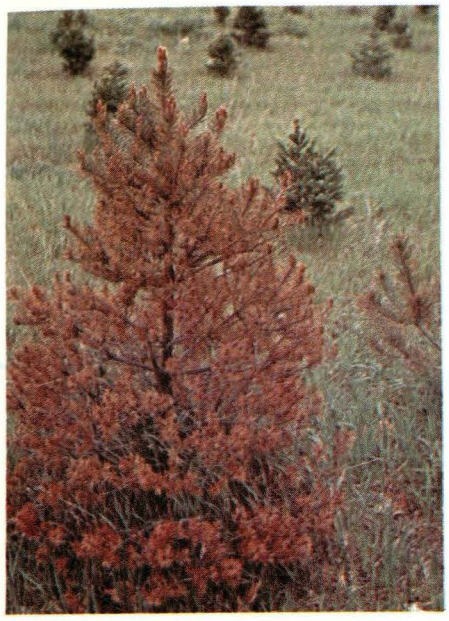

Figure 10.--L. pinastri-*infected Scotch pine Christmas tree. (Picture taken during the spring of 1973.)*

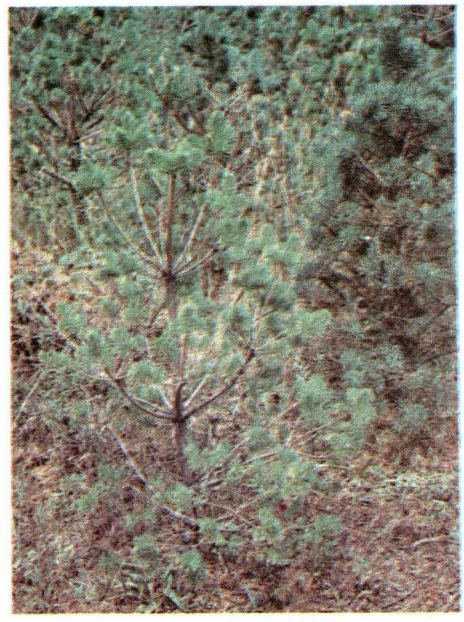

Figure 13.--*By late summer and fall only current-year needles remain on heavily infected trees. Such trees are of poor quality and not salable as Christmas trees.*

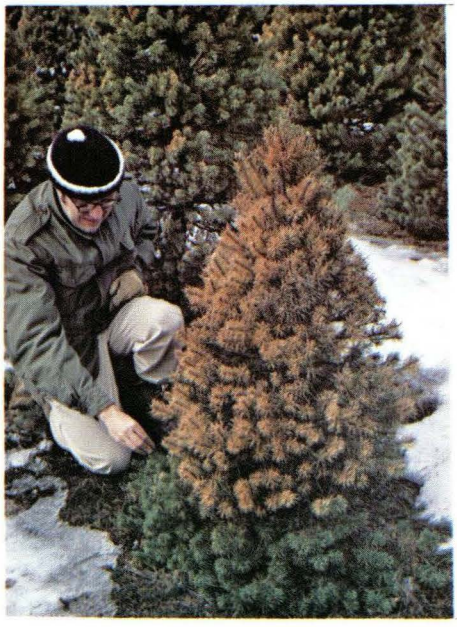

Figure 11.--*A winter-burned Scotch pine Christmas tree during the spring of 1972. Note how the branches that were below the snowline, and protected from the wind and sun, remained green. Compare this to figure 10 where* Lophodermium *has infected all of the foliage including the branches next to the ground.*

Figure 14.--*Here a nursery manager is closely checking for the presence of* L. pinastri *on red pine nursery stock under the guidance of a plant pathologist. Early detection and control of* Lophodermium *will prevent serious economic losses.*

Figure 15.--*A highboy hydraulic sprayer used by some Christmas tree growers to apply fungicides to tree foliage.*

Figure 17.--*In large plantations aerial spraying may be the most economical method of applying a control fungicide.*

Figure 16.--*A roto-blast mist blower is generally the most economical method of applying a fungicide in Christmas tree plantations for* Lophodermium *control. In some situations, aircraft application may be somewhat more economical (see fig. 17).*

Figure 18.--*Hydraulic sprayers are used by nurseries to apply maneb or chlorothalonil to red and Scotch pine beds for* Lophodermium *control.*

Some States have restrictions on the use of certain pesticides. Check your State and local regulations. You should consult your county agricultural agent or State extension specialist to be certain the intended use has been or is still registered because registrations of pesticides are under constant review by the Federal Environmental Protection Agency.

Bordeaux mixture, which has been used extensively for control of brown spot (*Scirrhia acicola*) in Christmas tree plantations, is not effective against *Lophodermium* and is not recommended.

Application Equipment

Most Christmas tree growers use hydraulic sprayers, mist blowers, or aircraft for fungicide spraying (figs. 15, 16, and 17) while most nurserymen use hydraulic sprayers (fig. 18). To be effective, sprayers must be operated at sufficient pressure to completely moisten all tree foliage. A tank agitator is recommended to ensure uniform dispersion of the fungicide; this prevents the fungicide from settling to the bottom of the tank. The agitator should be operated while (a) the tank is filling with water, (b) the fungicide is being added, and (c) the fungicide is being applied.

Chemical Concentrations And Methods of Application

As shown in table 1, chlorothalonil or maneb should be applied at the rate of 2-1/2 lb commercial/acre in 100 gal of water using a hydraulic sprayer. If flowable chlorothalonil is used, 2-1/2 pt in 100 gal of water would be required. A surfactant (such as DuPont spreader-sticker) is needed for maneb; the amount needed is 4 oz/100 gal of water. *A spreader-sticker is not needed for chlorothalonil.*

Nurseries.--Spray nozzles on hydraulic sprayers should be held within 15 to 20 in. of the trees. Nozzles should be spaced about 20 in. apart on the spray boom. Depending upon the age class of the trees being sprayed, the boom can be lowered or raised to provide full coverage of the foliage. About 2-1/2 lb of fungicide in 100 gal of water will cover about an acre if a flat spray Tee Jet nozzle No. 8008 (52 GPA) is used on a hydraulic sprayer moving at 3 mi/h.

Table 1.--*Amount of commercial maneb or chlorothalonil (wettable powder) needed to control* Lophodermium *according to different kinds of application equipment*

Equipment	Fungicide[1]	Water	Approximate area of coverage
	Lbs	*Gal*	*Acres*
Hydraulic sprayer	2-1/2	100	1
Roto-mist blower	6	100	2-1/2
Low-volume mist blower	12-1/2	100	5
Fixed-wing aircraft	2-1/2	5-10	1

[1]*If flowable chlorothalonil is used, 1 pt is equal to 1 lb of wettable powder.*

Christmas tree plantations.--Mist blowers moving at 2 mi/h will cover more area per hour (8 acres) than hydraulic sprayers in Christmas tree plantations. Thus, the hydraulic sprayers are more expensive to operate, but they do provide good coverage. Hydraulic sprayers use about 100 gal of water/acre; roto-mist blowers only about 40 gal/acre. Consequently, the fungicide concentration used for hydraulic sprayers (2-1/2 lb/100 gal of water) is much lower than that used for the roto-mist blowers (6 lb/100 gal of water). These mist blowers develop windspeeds up to 95 mi/h and up to 15 rows of trees can be sprayed where trees can be sprayed from both sides of a road (fig. 16). The new low-volume mist blowers use only about 20 gal/acre; thus, the fungicide concentration would be 12-1/2 lb/100 gal of water to obtain field coverage of 2-1/2 lb/acre.

Safety Precautions

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of reach of children and animals and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

CULTURAL PREVENTATIVES

There also are a number of cultural practices that nurserymen and growers can follow that will either prevent *Lophodermium* infection or reduce its severity.

Nursery

- Windbreaks should not be of the same species as grown in adjacent nursery beds. Nurseries experiencing *Lophodermium* losses often have red or Scotch pine windbreaks adjacent to the nursery beds. Infected windbreaks may play a major role in the buildup of *L. pinastri* when spores or infected needles having fungus fruiting bodies are blown into nursery beds.

- Transplant stock should not be brought into nurseries from other areas. Several new diseases have been introduced from one nursery to another by shipping infected stock between nurseries.

- Do not ship infected nursery stock for outplanting. This will prevent the development of an epidemic in the field caused by infected nursery stock.

- If irrigation is needed in late summer and fall, it should be done in the morning to allow the trees time to dry during the afternoon. This prevents prolonged periods of moisture that are conducive to *Lophodermium* infection.

Plantation

- Plant only healthy nursery stock. This seems obvious enough, but many times the grower is so eager to get the plantation established that he will plant unhealthy trees. If stock has turned brown when received, or if it has numerous infection spots on the foliage, the trees should be examined by a plant pathologist before they are planted. Infected trees should be returned to the nursery because it is far cheaper to keep disease out of a plantation than to control it once it is established. Although State nursery inspection is improving, there have been many cases in recent years where stock was shipped from nurseries with foliage diseases present.

- Avoid planting Scotch pine seedlings next to Scotch pine windbreaks. These windbreaks frequently serve as a reservoir for the *Lophodermium* fungus as well as other insect and disease problems. These windbreaks should be cut and burned the year before a new stand is planted. Stumps should either be removed or treated with a registered insecticide.

- Avoid shipping diseased Christmas trees. Christmas trees are shipped to many different parts of the country. This is a good way for a disease to be transported and to become established in new areas.

- When harvesting trees, especially in infected plantations, avoid leaving live branches on stumps. These lower branches are especially susceptible to foliage

disease problems and their needles serve to perpetuate the *Lophodermium* fungus.

- Do not plant just one species or variety. To avoid catastrophic losses, a grower should not plant his land with only one species or variety of conifer. If a disease damages one species, there is a good chance that it will not damage other species being grown.

- Plant resistant Scotch pine varieties or other conifer species. Avoid planting highly susceptible short-needled Scotch pine varieties such as the "Spanish" and "French-green" varieties. Long-needled Scotch pine varieties such as the "Scottish Highland" or "Austrian Hills" are more resistant to attack. Other conifer species such as white pine, white and blue spruce, and balsam fir could be planted for Christmas trees to avoid *Lophodermium* damage. However, these species sometimes are attacked by other species of fungi.

Resistance to *Lophodermium* may eventually be increased by selecting resistant provenances or individual trees and by breeding resistant strains. Research of this type will be necessary if Scotch pine continues as the number one Christmas tree produced and bought in the United States. Red pine appears to acquire resistance to the fungus as trees get older, unlike Scotch pine, which appears to be susceptible at all ages. This may be the reason we have not observed a *Lophodermium* outbreak in red pine Christmas tree plantations even though heavy damage has occurred to red pine seedlings in some tree nurseries.

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